

PATENT ABSTRACTS OF JAPAN

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(21)Application number : 10-319994 (71)Applicant : RICOH CO LTD

(22)Date of filing : 23.10.1998 (72)Inventor : KOMATSU MANABU
SUZUKI HIROAKI

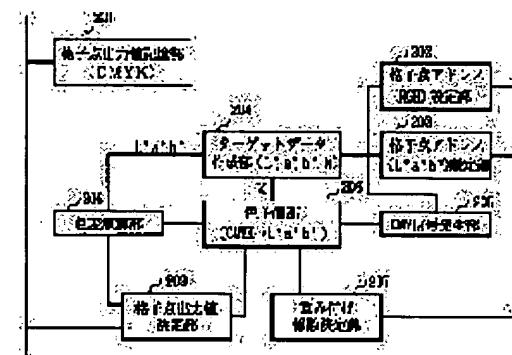
(54) COLOR CONVERSION COEFFICIENT DETERMINING DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a device which determine color conversion coefficients actualizing color conversion between color output devices so that color matching and superior continuity are obtained in the entire color space.

SOLUTION: A weighting coefficient determination part 207 sends a weighting coefficient corresponding to a grating point address ($L^*a^*b^*$ value) to a color prediction part 206, which calculates a final color predicted value ($L^*a^*b^*$) from a color predicted value by a hierarchical neural net and a color predicted value by a hue division type linear model according to the weighting coefficient.

Here, the weighting coefficient determined by the weighting coefficient determination part 207 is so calculated that continuous conversion is performed through table conversion, etc., in an input color space (CIELAB) by referring to the variation quantity of a colorimetric value for the variation quantity of the color material coordinate value of, for example, a color output device.



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CLAIMS

[Claim(s)]

[Claim 1] The input chrominance signal of arbitration is changed into the control signal of a color picture output device by the operation of a color transform coefficient. It is color transform coefficient decision equipment which determines said color transform coefficient with the color predictive model which learned the color-material coordinate and colorimetry value of a color picture output device. The color-material coordinate of at least two kinds of color picture output devices, and the color predictive model which learned the colorimetry value, Color transform coefficient decision equipment characterized by having a color prediction means to predict the color of a color picture output device with said color predictive model which changed weighting, and a color correction factor decision means to determine said color correction factor based on prediction of this color prediction means, according to a standard color space coordinate.

[Claim 2] Modification of said weighting is color transform coefficient decision equipment according to claim 1 characterized by determining the lightness and the highest saturation of a color picture output device for every hue in a standard color space as criteria.

[Claim 3] The input chrominance signal of arbitration is changed into the control signal of a color picture output device by the operation of a color transform coefficient. It is color transform coefficient decision equipment which determines said color transform coefficient with the color predictive model which learned the color-material coordinate and colorimetry value of a color picture output device. The color-material coordinate of at least two kinds of color picture output devices, and the color predictive model which learned the colorimetry value, A color prediction means to predict the color of a color picture output device with said color predictive model which changed weighting according to the color-material coordinate of a color picture output device, Color transform coefficient decision equipment characterized by having a color correction factor decision means to determine said color correction factor, based on prediction of this color prediction means.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Field of the Invention] This invention relates to the color transform coefficient decision equipment which determines the color transform coefficient used with the color inverter which changes an input signal into the control signal of a color output unit.

[0002]

[Description of the Prior Art] Generally, as for the conversion to the device independent CMYK signal which is a control signal of a color output unit from the $L^* a^* b^*$ signal in a color output unit, the matrix operation and the interpolation operation of a look-up table are used. For example, in JP,5-22586,A, although a color transform function is derived The algorithm which learns function amendment of a high order term performs to linear transformation, linear transformation, and a degree gradually first. In each phase The parameter of a certain transform function of a kind of is learned, the parameter of the transform function obtained in the 1st step is not changed after it, and the color conversion system which the parameter of the transform function obtained in the 2nd step becomes from the equipment which has each process which is not changed in the stage after it is indicated. Moreover, in JP,8-102865,A, the color transform coefficient decision approach determined by the neural network who learned the actual measurement of the color-material coordinate value corresponding to the input color coordinate and this in the equipment which performs color conversion for the lattice point data of a look-up table is indicated in the approach of determining the lattice point data of a look-up table which change an input color coordinate value into the color-material coordinate value of a color picture output unit.

[0003]

[Problem(s) to be Solved by the Invention] With the technique which used the neural network (the error reverse spreading method) etc. for the above highly precise color transform coefficient decision, by there being a field (for example, high concentration section) with few colorimetry value changes to change of each color of the control signal CMYK of a color output unit, when inverse transformation which actually asks for a color transform coefficient is carried out, a value cannot become settled easily uniquely, and there is a problem in the continuity of gradation etc. moreover, the color reproduction of a color output unit -- there was a problem also in the dependability in a color, i.e., a non-learned field.

[being out of range (near)] Then, the 1st purpose of this invention is offering the color transform coefficient decision equipment which determines the color transform coefficient which realizes color conversion between the color output devices which carried out color matching and were excellent in the continuity in all color spaces.

[0004] The 2nd purpose of this invention is grasping the property of the color output device in a standard color space in a detail, and is offering the color transform coefficient decision equipment which determines the color transform coefficient which realizes color conversion between the color output devices which carried out color matching and were excellent in the continuity in all color spaces. The 3rd purpose of this invention is easy technique (short time), and is offering the color transform coefficient decision equipment which determines the color transform coefficient which realizes color

conversion between the color output devices which carried out color matching and were excellent in the continuity in all color spaces.

[0005]

[Means for Solving the Problem] In invention according to claim 1, the input chrominance signal of arbitration is changed into the control signal of a color picture output device by the operation of a color transform coefficient. It is color transform coefficient decision equipment which determines said color transform coefficient with the color predictive model which learned the color-material coordinate and colorimetry value of a color picture output device. The color-material coordinate of at least two kinds of color picture output devices, and the color predictive model which learned the colorimetry value, Said 1st purpose is attained by having had a color prediction means to predict the color of a color picture output device with said color predictive model which changed weighting, and a color correction factor decision means to determine said color correction factor based on prediction of this color prediction means, according to the standard color space coordinate.

[0006] In invention according to claim 2, modification of said weighting attains said 2nd purpose in invention according to claim 1 by determining the lightness and the highest saturation of a color picture output device for every hue in a standard color space as criteria.

[0007] In invention according to claim 3, the input chrominance signal of arbitration is changed into the control signal of a color picture output device by the operation of a color transform coefficient. It is color transform coefficient decision equipment which determines said color transform coefficient with the color predictive model which learned the color-material coordinate and colorimetry value of a color picture output device. The color-material coordinate of at least two kinds of color picture output devices, and the color predictive model which learned the colorimetry value, A color prediction means to predict the color of a color picture output device with said color predictive model which changed weighting according to the color-material coordinate of a color picture output device, Said 3rd purpose is attained by having had a color correction factor decision means to determine said color correction factor, based on prediction of this color prediction means.

[0008]

[Embodiment of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained to a detail with reference to drawing 1 thru/or drawing 5. First, the color inverter by the look-up table (lattice point output value) is explained as an example which changes an input chrominance signal into the control signal of a color output unit. When the CIELAB color space which is a typical color space is made into an input color space as shown in drawing 1 for example, a CIELAB color space is divided into a solid figure (here cube) of the same kind. And in order to calculate the lattice point output value P which is an input and which can be set a coordinate ($L^* a^* b^*$ value), a cube including the coordinate of said input is chosen and linear interpolation is carried out based on the location in the output value on the lattice point of eight points of the this chosen cube set up beforehand, and said cube of said input (distance from each lattice point).

[0009] Here, when it is the control signal of 4 color printer, the lattice point output value P is equivalent to C, M, Y, and K value, respectively. this input color space (CIELAB) -- inner -- the block block diagram of an example of lattice point output-value (color transform coefficient) decision equipment which determines the output value on all the lattice point (C, M, Y, K) is shown in drawing 2 R> 2. The lattice point output-value storage section which memorized the output value on the lattice point which 201 determined (C, M, Y, K) in drawing 2 , and 202 and 203 The lattice point address selection section which generates the lattice point address at the time of dividing into plurality the input color space which carries out color conversion (202:RGB and 203: $L^* a^* b^*$), and 204 Desired value ($L^* a^* b^*$) and $L^* a^* b^*$ of an output color corresponding to the lattice point address It is the Target date creation section which determines the ink volume K to an input.

[0010] 205 is the CMY signal generator which generates a suitable CMY signal according to the lattice point address. 206 It is the color prediction section which predicts the output color ($L^* a^* b^*$) of the color output unit to the CMY input from the CMY signal generator 205, and K input from the Target date creation section 204. With reference to the multiplier according to the lattice point address ($L^* a^*$

b^*), the lattice point address is generated from the weighting multiplier decision section of 207. 208 is the color difference operation part which computes the difference of the target color ($L^* a^* b^*$) determined in the Target date creation section 204, and the color ($L^* a^* b^*$) predicted in the color prediction section 206, and 209 is the lattice point output-value decision section which extracts the combination of CMY from which the color difference computed by the color difference operation part 208 (as opposed to $L^* a^* b^* K$) serves as min for every lattice point address.

[0011] Next, when actuation of this equipment is explained, they are RGB from the lattice point address selection sections 202 and 203, or $L^* a^* b^*$. The Target date creation section 204 which received the signal carries out range comprehension by linear transformation like a bottom type according to the lightness range of ink volume (in the case of a RGB input $L^* a^* b^*$ after conversion) K.

[0012]

[Equation 1] $L^* = L^* x(L_{white} - L_{black}) / 100 + L_{black}$, however L_{white} : The maximum lightness of an output unit (white point)

L_{black} : The minimum lightness of an output unit (black point)

[0013] Furthermore, at the Target date creation section 204, it is $L^* a^* b^*$. The ink volume K to a value defined beforehand is set up. About the method of setting up ink volume K, although set up in the range which generally does not exceed the maximum ink volume (ink volume which does not narrow the color reproduction range) although various approaches are proposed, finally according to the property of a color output unit, the suitable ink volume K is determined.

[0014] $L^* a^* b^*$ to the lattice point address created in the Target date creation section 204 In order to look for the combination of CMY of the color output unit reproducing the (K) value, in the color prediction section 206, the property (CMY-> $L^* a^* b^*$) of a color output unit is expected. In order to find a solution early by the CMY signal generator 205 in that case, sequential generating of the CMY signal according to the lattice point address is carried out.

[0015] The color prediction section 301 according to a hierarchical neural network as the color prediction section 206 is shown in drawing 3, Consist of the color prediction section 302 by the hue assembled-die linear model, and in the color prediction section 301 by the hierarchical neural network. By the error reverse spreading method using a hierarchical neural network, it is $L^* a^* b^*$ from the white point of CMYK monochrome. The relation of the colorimetry value ($L^* a^* b^*$) of distance and color mixture is learned. At the color prediction section 302 by the hue assembled-die linear model, it is $L^* a^* b^*$ from the white point of CMYK monochrome by the minimum square error method for every same color phase in a CIELAB color space. The relation of the colorimetry value ($L^* a^* b^*$) of distance and color mixture is learned.

[0016] The weighting multiplier decision section 207 calculates a final color forecast ($L^* a^* b^*$) in delivery and the color prediction section 206 according to a weighting multiplier from the color forecast according the weighting multiplier according to the lattice point address ($L^* a^* b^*$ value) to a hierarchical neural network, and the color forecast by the hue assembled-die linear model in the color prediction section 206. Here, in an input color space (CIELAB), the weighting multiplier determined in the weighting multiplier decision section 207 is table conversion modeled after the amount of colorimetry value changes to the variation of the color-material coordinate value of a color output device etc., and it is calculated so that it may change continuously. In addition, the configuration of the color prediction section 206 shown in this drawing 3 is an example, and is not limited to this.

[0017] In the color operation part 208, a difference with the color ($L^* a^* b^*$) predicted in the color prediction section 206 is computed, and it sets in the lattice point output-value decision section 209, and is $L^* a^* b^*$. The combination of CMY from which the color difference over (K) serves as min (sequential generating was carried out by the CMY signal generator 205) is extracted for every lattice point address, and the lattice point output-value storage section 201 is made to memorize.

[0018] Next, the gestalt of the 2nd operation is explained. Drawing 4 is the block block diagram of the equipment concerning the gestalt of the 2nd operation. In this drawing 4, 410 is the device property storage section which memorized each hue of the color output device in an input color space (CIELAB), and the highest saturation (color reproduction range) for every lightness. The weighting multiplier

decision section 407 computes the hue of the lattice point address ($L^* a^* b^*$ value), and saturation, and is based on the same color phase of the color output device in the device property storage section, and the highest saturation (color reproduction range) in this lightness for them. A weighting multiplier is calculated and a final color forecast ($L^* a^* b^*$) is calculated according to this weighting multiplier from the color forecast of the color prediction section 301 by the hierarchical neural network, and the color forecast of the color prediction section 302 by the hue assembled-die linear model (R> drawing 3 3 reference).

[0019] Here, the specific gravity of the color forecast of the color prediction section 302 by the hue assembled-die linear model is raised (curves differ according to a hue and lightness), and about the lattice point address outside the highest saturation of a color output device ($L^* a^* b^*$ value), it calculates so that the color forecast of the color prediction section 301 by the hierarchical neural network may not be used and it may change continuously, as it approaches near the highest saturation of a color output device fundamentally. In delivery and the color prediction section 206, a final color forecast ($L^* a^* b^*$) is calculated according to a weighting multiplier from the color forecast according the weighting multiplier according to the lattice point address ($L^* a^* b^*$ value) to a hierarchical neural network, and the color forecast by the hue assembled-die linear model in the color prediction section 206. Here, in an input color space (CIELAB), the weighting multiplier determined in the weighting multiplier decision section 207 refers to the amount of colorimetry value changes to the variation of the color-material coordinate value of a color picture device etc., and it calculates it so that it may change continuously.

[0020] Next processing is the same as that of the gestalt of the 1st operation, a difference with the color ($L^* a^* b^*$) predicted in the color prediction section 406 is computed in the color difference operation part 408, and it is the lattice point output-value decision section 409. $L^* a^* b^*$ The combination of CMY from which the color difference over (K) serves as min (sequential generating was carried out by the CMY signal generator 405) is extracted for every lattice point address, and the lattice point output-value storage section 401 is made to memorize.

[0021] Next, the gestalt of the 3rd operation is explained. Drawing 5 is the block block diagram of the equipment concerning the gestalt of the 3rd operation. RGB or $L^* a^* b^*$ from the lattice point address selection sections 502 and 503 The Target date creation section 504 which received the signal carries out range comprehension by linear transformation like the aforementioned formula according to the lightness range of ink volume (in the case of a RGB input $L^* a^* b^*$ after conversion) K. Furthermore, at the Target date creation section, it is $L^* a^* b^*$. The ink volume K to a value defined beforehand is set up.

[0022] $L^* a^* b^*$ to the lattice point address set up in the Target date creation section 504 In order to look for the combination of CMY of the color output unit reproducing the (K) value, in the color prediction section 506, the property (CMYK-> $L^* a^* b^*$) of a color output unit is expected. In order to find a solution early by the CMY signal generator 505 in that case, sequential generating of the CMY signal according to the lattice point address is carried out. The color prediction section 301 according to a hierarchical neural network as the color prediction section 506 is shown in drawing 3 , Consist of the color prediction section 302 by the hue assembled-die linear model, and in the color prediction section 301 by the hierarchical neural network By the error reverse propagation approach using a hierarchical neural network, it is $L^* a^* b^*$ from the white point of CMYK monochrome. The relation of the colorimetry value ($L^* a^* b^*$) of distance and color mixture is learned. At the color prediction section 302 by the hue assembled-die linear model, it is $L^* a^* b^*$ from the white point of CMYK monochrome by the minimum square error method for every same color phase in a CIELAB color space. The relation of the colorimetry value ($L^* a^* b^*$) of distance and color mixture is learned.

[0023] The weighting multiplier decision section 507 calculates a final color forecast ($L^* a^* b^*$) in delivery and the color prediction section 506 according to a weighting multiplier from the color forecast according the weighting multiplier according to the color-material coordinate (CMYK) of the color output device sent from the CMY signal generator 505 and the Target date creation section 504 to a hierarchical neural network, and the color forecast by the hue assembled-die linear model in the color prediction section 506. Here, with reference to the total value (total amount) of the color-material

coordinate value (CMYK) of for example, a color picture device etc., the weighting multiplier determined in the weighting multiplier decision section 507 is calculated so that it may change continuously. In the color difference operation part 508, a difference with the color ($L^* a^* b^*$) predicted in the color prediction section 506 is computed, and it sets in the lattice point output-value decision section 509, and is $L^* a^* b^*$. The combination of CMY from which the color difference over (K) serves as min (sequential generating was carried out by the CMY signal generator 505) is extracted for every lattice point address, and the lattice point output-value storage section 501 is made to memorize.

[0024]

[Effect of the Invention] In invention according to claim 1, the color transform coefficient which realizes color conversion between the color output devices which carried out color matching and were excellent in the continuity can be determined in all color spaces including a field with few amounts of colorimetry value changes to the variation of the color-material coordinate value of a color output device.

[0025] In invention according to claim 2, the color transform coefficient which realizes color conversion between the color output devices which have grasped the property of the color output device in a standard color space in the detail, and carried out color matching in all color spaces including the field (outside of a color reproduction field) in which precision like a non-learning field is inferior, and were excellent in the continuity can be determined.

[0026] In invention according to claim 3, the color transform coefficient which realizes color conversion between the color output devices which carried out color matching in all color spaces including a field with few amounts of colorimetry value changes to the variation of the color-material coordinate value of a color output device, and were excellent in the continuity with easy technique (short time) can be determined.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing explaining processing of the gestalt of operation of this invention.

[Drawing 2] It is the block block diagram of the color transform coefficient decision equipment concerning the gestalt of operation of the 1st of this invention.

[Drawing 3] It is drawing explaining the gestalt of operation of the 1st of this invention.

[Drawing 4] It is the block block diagram of the color transform coefficient decision equipment concerning the gestalt of operation of the 2nd of this invention.

[Drawing 5] It is the block block diagram of the color transform coefficient decision equipment concerning the gestalt of operation of the 3rd of this invention.

[Description of Notations]

201 Lattice Point Output-Value Storage Section

202 203 Lattice point address selection section

204 Target-date creation section

205 CMY Signal Generator

206 Color Prediction Section

207 Weighting Multiplier Decision Section

208 Color Difference Operation Part

209 Lattice Point Output-Value Decision Section

302 Color Prediction Section

407 Weighting Multiplier Decision Section

410 Device Property Storage Section

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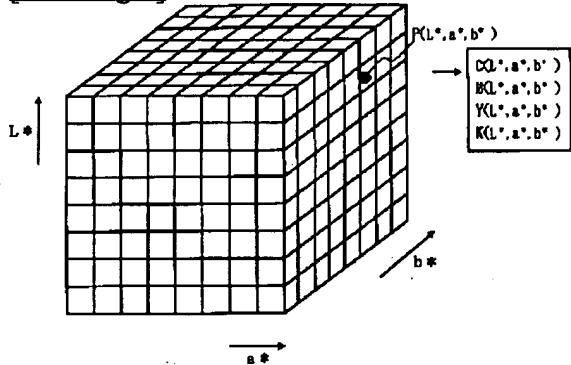
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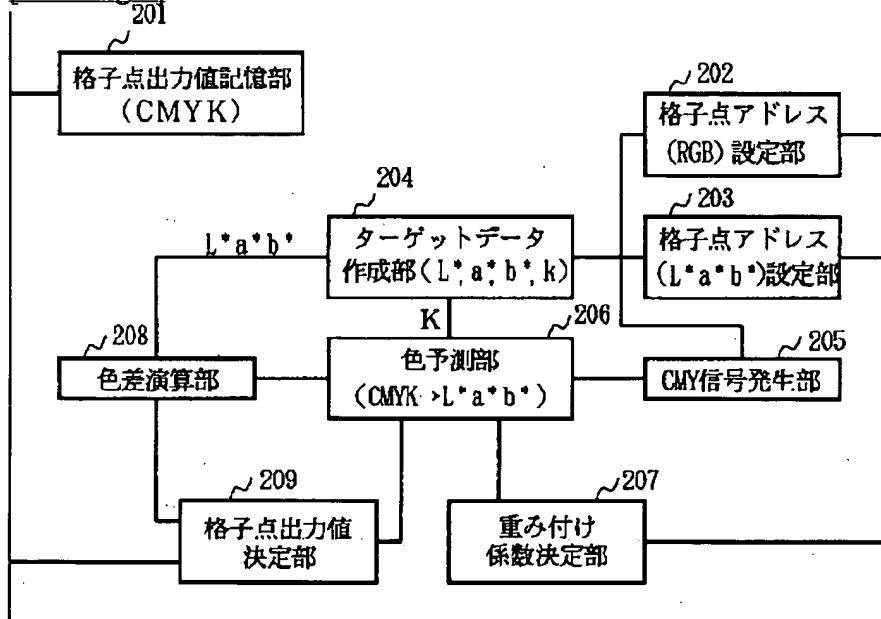
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DRAWINGS

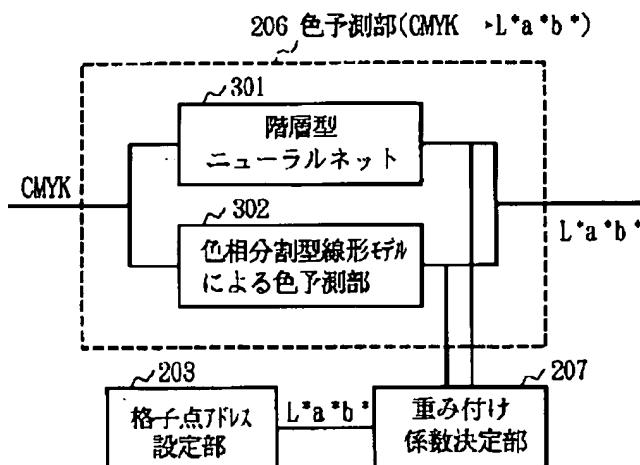
[Drawing 1]



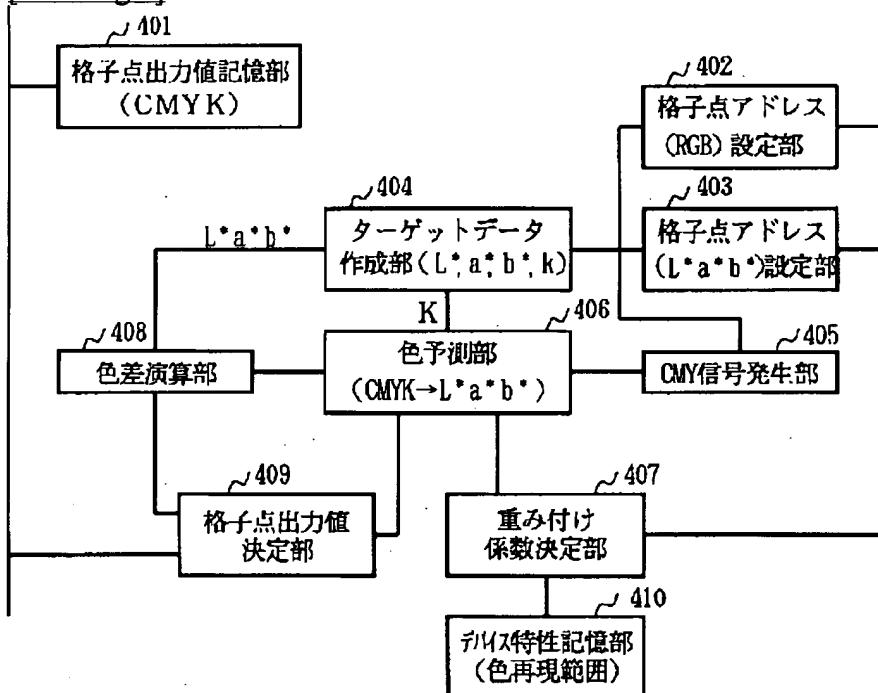
[Drawing 2]



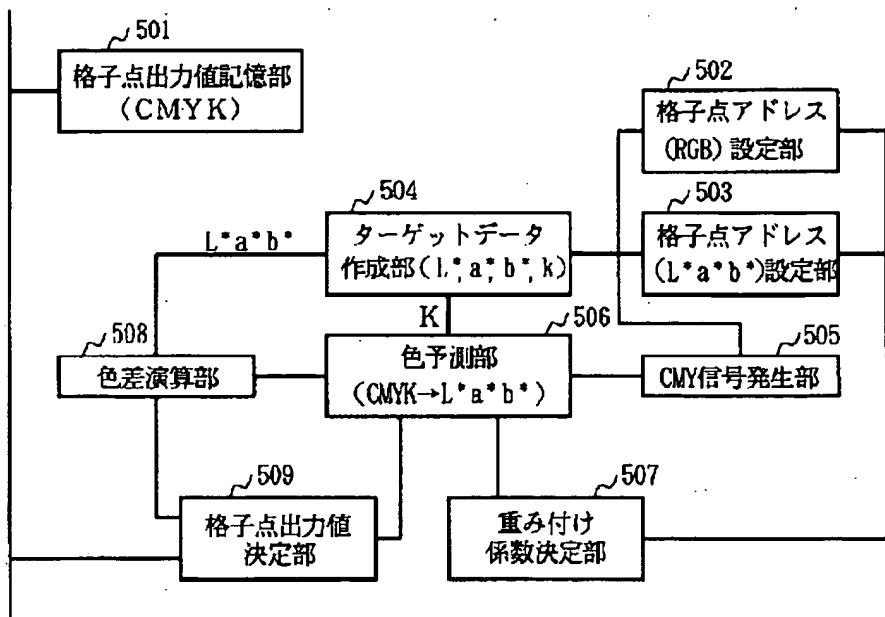
[Drawing 3]



[Drawing 4]



[Drawing 5]



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